



CEREBROSPINAL FLUID LEAK PREVENTION AND MANAGEMENT IN ENDOSCOPIC PITUITARY SURGERY: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Endoscopic transsphenoidal surgery has transformed the treatment of pituitary adenomas and other lesions of the sella. The most common complication remains cerebrospinal fluid (CSF) leakage, which is frequently associated with meningitis, extended hospitalization, and increased morbidity. Over the past twenty years, a systematic reconstruction method, especially with the addition of vascularized nasoseptal flaps, has lowered CSF leak rates (Hadad et al, 2006). **Objective:** To present a comprehensive review of current practices for prevention and management of CSF leaks in endoscopic pituitary surgery. **Methods:** Published studies dating from 2000-2025 were reviewed. Studies discussing the incidence of CSF leaks, risk factors, reconstruction technique, and outcomes of CSF leakage repairs related to endoscopic transsphenoidal surgery were included. Pediatric-only studies and case reports were excluded. **Results:** The incidence of postoperative CSF leaks after ETSS varies from 2% to 30% dependent on tumor size and extent of approach (Komotar et al, 2012; Kassam et al, 2015). Risk factors associated with CSF leakage include giant adenomas, extended approaches, intraoperative high-flow leaks, and revision surgeries. In studies that used vascularized nasoseptal flap reconstruction, CSF leak rates dropped below 5% (Hadad et al, 2006; Esposito et al, 2007). A common plan for reconstruction is considered a "graded" repair: fat/fibrin glue for low-flow leaks, and multilayer vascularized reconstruction for high-flow leaks (Esposito et al, 2007). A lumbar drain can be used for high-risk patients.

KEYWORDS : Pituitary Surgery, CSF Leak, Complications of Pituitary Surgery

INTRODUCTION

The endoscopic transsphenoidal approach has emerged as the standard for pituitary adenoma resection, supplanting older microscopic techniques in nearly all specialty centers. The endoscope's panoramic, angled view raises resection rates and decreases morbidity during surgery (Komotar et al., 2012). Nevertheless, leaks of cerebrospinal fluid remain the most prevalent complication, with reported rates ranging in the literature from 2–30% (Komotar et al., 2012; Kassam et al., 2015). These reported rates reflect a variety in tumor size, surgical experience, and even reconstruction techniques.

Unclosed or persistent leaks may lead to few sequelae, including meningitis, pneumocephalus, delayed healing, and possibly revision surgery, which makes prevention and careful repair compulsory. Improvements in skull base reconstruction techniques—particularly involving the vascularized nasoseptal flap first describe by Hadad and Bassagasteguy (2006)—have changed the prognosis for leaks.

METHODS

- **Eligibility:** Articles published from 2000 to 2025 that reflected on CSF leak prevention or management after endoscopic pituitary surgery
- **Exclusion:** Case reports, pediatrics, non-endoscopic methods
- **Data extracted:**
 - CSF leak incidence
 - Risk factors
 - Repair modalities (free grafts, multilayer, vascularized flaps)
 - Postoperative management approaches
 - Outcomes and recurrence
- **Definitions:**
 - Low-flow leak: oozing from arachnoid defects, typically not associated with major disruption of the diaphragmatic
 - High-flow leak: large defects or direct communication with cisterns/ventricles with brisk egress of CSF

RESULTS

Occurrence of CSF Leaks

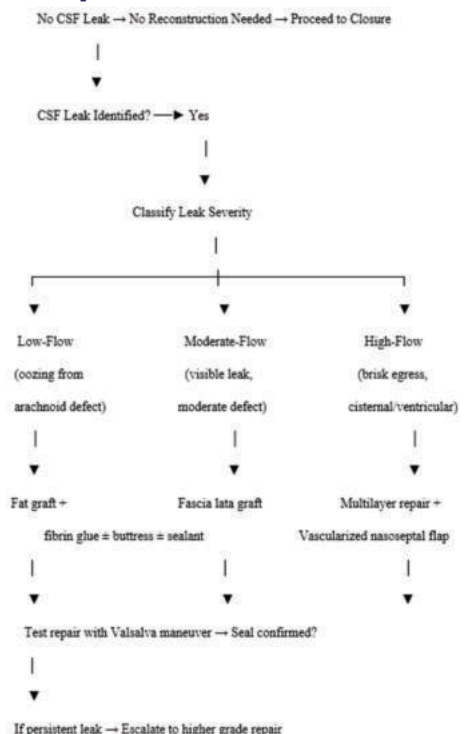
Current incidence rates of postoperative leaks with modern reconstruction of standard endoscopic transsphenoidal surgery is consistently <5% (Hadad et al., 2006; Esposito et al.,

2007). Extended approaches to the clivus or planum sphenoidale continue to have higher rates (7–10%) (Kassam et al., 2015).

Risk Factors

- **Tumor-related:** giant adenomas, suprasellar extension, craniopharyngiomas, Rathke's cleft cysts (Komotar et al., 2012).
- **Surgical:** intraoperative high-flow leaks, extended approaches, revision surgery (Esposito et al., 2007).
- **Patient-related:** obesity, prior radiotherapy, chronic high ICP (Kassam et al., 2015).

Repair Techniques



Graded Repair Strategy (Esposito et al., 2007):

- Grade 0: No leak → no graft required
- Grade 1 (low-flow): Fat/fibrin sealant
- Grade 2 (moderate): Fascia lata graft + buttress
- Grade 3 (high-flow): Multilayer closure + vascularized flap

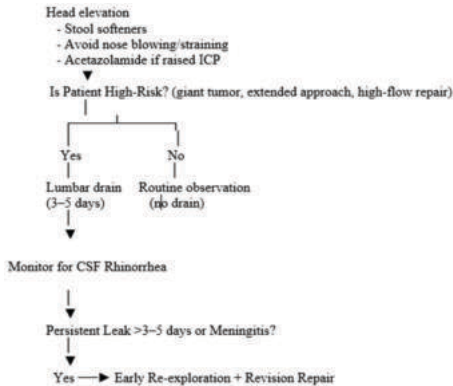
Comparative Summary of Reconstruction Techniques

Technique	Best Indication	Reported Leak Rate (%)	Advantages	Limitations	Key References
Fat graft + fibrin glue	Small, low-flow leaks	5–10	Simple, readily available	Not durable for high-flow leaks	Esposito et al., 2007
Fascia lata graft + buttress	Moderate-flow leaks, medium defects	4–8	Robust, strong coverage	Donor site morbidity	Esposito et al., 2007
Naso-septal flap (Hadad-Bassagasteguy)	High-flow leaks, extended approaches	1–5	Vascularized, large surface area, reliable	Not usable if septum previously resected or irradiated	Hadad et al., 2006
Inferior turbinate or lateral nasal wall flaps	Revision cases where septum unavailable	3–7	Salvage option	Smaller surface area, variable reach	Kassam et al., 2015
Lumbar drain (adjunct)	High-risk patients, high-flow leaks	3–7 (with flap)	Reduces CSF pressure on repair	Risks: meningitis, over-drainage, headache	Komotar et al., 2012

Postoperative Management

- **Conservative Measures:** Head elevation, avoidance of straining, stool softeners, and acetazolamide in cases with raised intracranial pressure (Esposito et al., 2007).
- **Lumbar Drainage:** Effective as an adjunct in high-flow leaks but not recommended routinely due to complication risks (Komotar et al., 2012).
- **Persistent Leaks:** CSF rhinorrhea beyond 3–5 days warrants prompt re-exploration rather than prolonged conservative management (Kassam et al., 2015).

All Patients → General Measures:



DISCUSSION

The use of a vascularized nasoseptal flap has significantly changed the game by decreasing postoperative leaks from rates of 15–30% to <5% (Hadad et al., 2006; Komotar et al., 2012). The graded repair technique balances the appropriate

use of resources against morbidity (Esposito et al., 2007). While lumbar drains can potentially aid in healing, they should not be used indiscriminately due to risks of overdrainage and meningitis (Komotar et al., 2012). Persistent leaks should be treated with early re-exploration, rather than conservative treatment (Kassam et al., 2015). Future advances may include bioengineered dural substitutes, new sealants, and AI-helped intraoperative machines.

CONCLUSION

A CSF (cerebrospinal fluid) leak is the most common complication associated with endoscopic pituitary surgery. The prevention and management of a CSF leak depends upon these four items:

- Attention to detail with intraoperative technique
- Awareness and recognition of the severity of the leak as early as possible
- Graded and individualized approach to the reconstruction
- Vascularized flaps for high-flow leaks

Leak rates after surgery have been documented reliably under 5% with modern techniques.

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